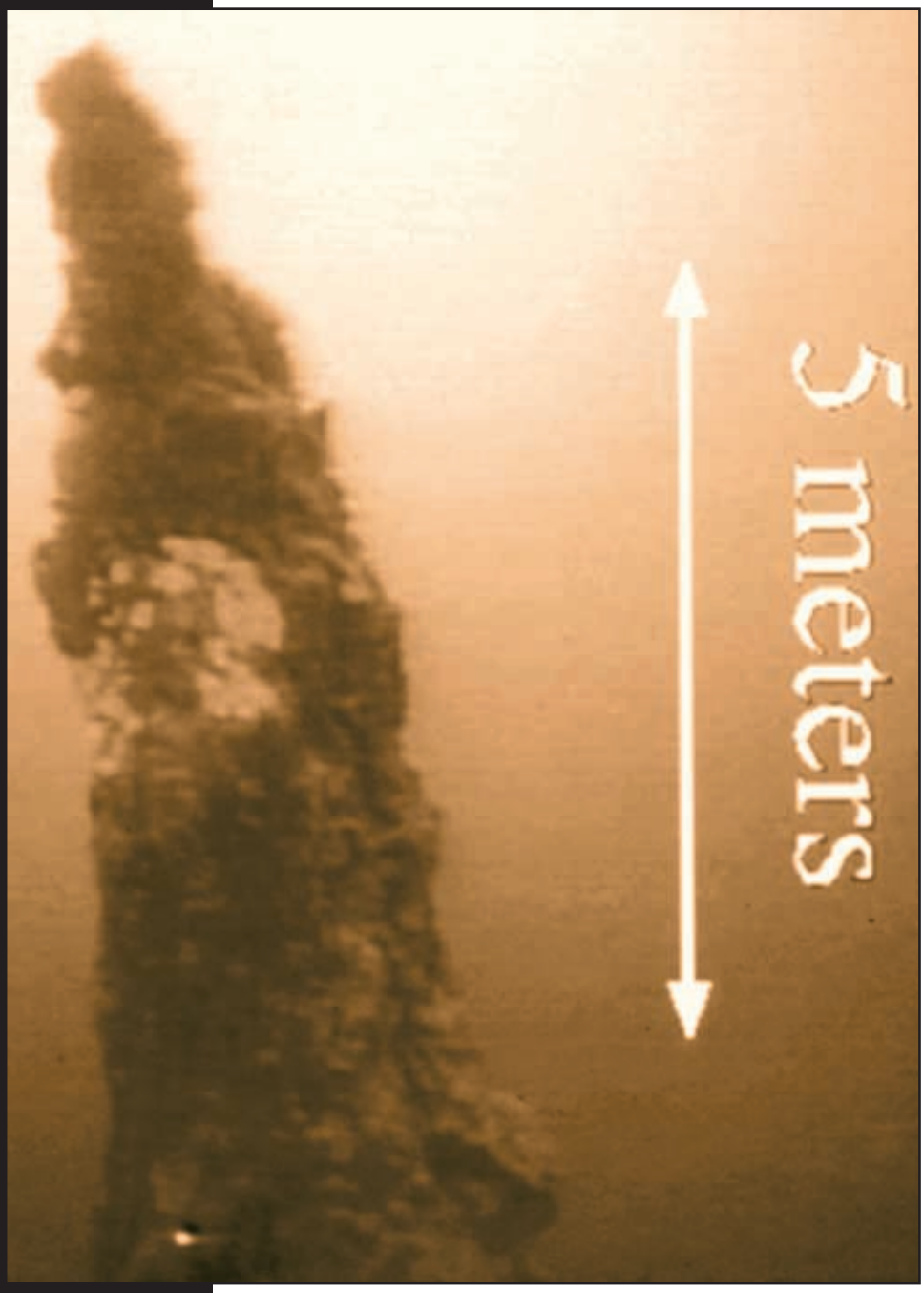

At more than 5 meters in height, *this spire is one of hundreds discovered in 1999 on the floor of Yellowstone Lake by researchers conducting surveys of the lake bottom. The spires occur singly or in clusters and may be up to 35 meters high.*

Relatively intact ecosystems, many of which are found in the national park system, can provide excellent locations for natural resource-related research. In places where human influences are minimal, research can focus on such natural systems and their functions in ways that might be impossible in highly disturbed sites. Moreover, with their diverse resources, national parks are very desireable places for researchers. Additionaly, they provide opportunites to study the relationship of people to parks. Whether the goal of scientific inquiry is to illuminate new information to increase academic understanding or to apply it to societal needs, including the preservation of park resources, parks are labratories that contain untold numbers of facinating interactions and valuable applications. As the articles in this Year in Review *demonstrate, the National Park Service relies on scientific information developed by research partners and baseline data collected by its own staff for application in the management of park natural resources and the evaluation of resource management programs. For all these reasons, the Park Service will continue to make parks friendlier places for scientific inquiry.*

New Discoveries

The underwater spires of Yellowstone Lake

by Sue Consolo Murphy with Lisa Morgan

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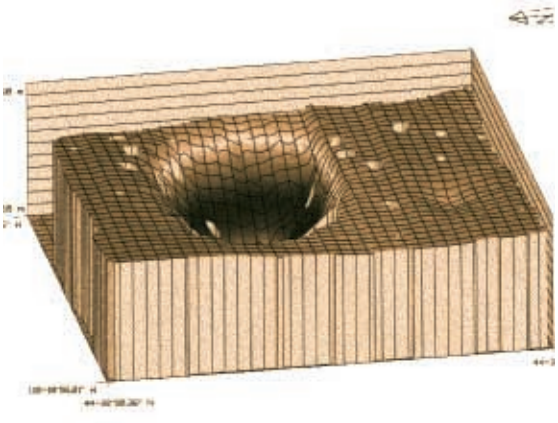
For more than a decade, researchers have been exploring the underwater environment of Yellowstone Lake. While visitors to Yellowstone may be more enamored of its fish population or the eagles and ospreys flying overhead, scientists have been eager to map and explore the thermal influences apparent even at several hundred–foot depths of this cold, high-mountain lake. An underwater roving vehicle had photographed thermal vents, and in 1997 an intriguing set of pinnacle-like "spires" was discovered in a section of the lake's floor that lies entirely within the 630,000-year-old Yellowstone caldera.

In July 1999, scientists from the U.S. Geological Survey, the Great Lakes WATER Institute at the University of Wisconsin at Milwaukee, and Eastern Oceanics returned to help the National Park Service begin conducting high-resolution bathymetric, seismic reflection, and magnetic mapping surveys of the lake. Although they were able to intensively map only the northern quarter of Yellowstone Lake, they discovered an array of interesting features, including dozens of circular, steep-walled depressions from 5 to 500 meters across (16–1,640 feet), and hundreds of pinnacles and spires. Some spires may be up to 35 meters tall (115 feet) and some are 50 meters (164 feet) in diameter; they occur singly or in clusters.

Under the direction of the researchers, members of the park dive team found and collected small spire samples near the mouth of Bridge Bay. The scientists waiting on the water's surface greeted the specimens with great delight and awe. Scientists took the spire samples, which had a light-



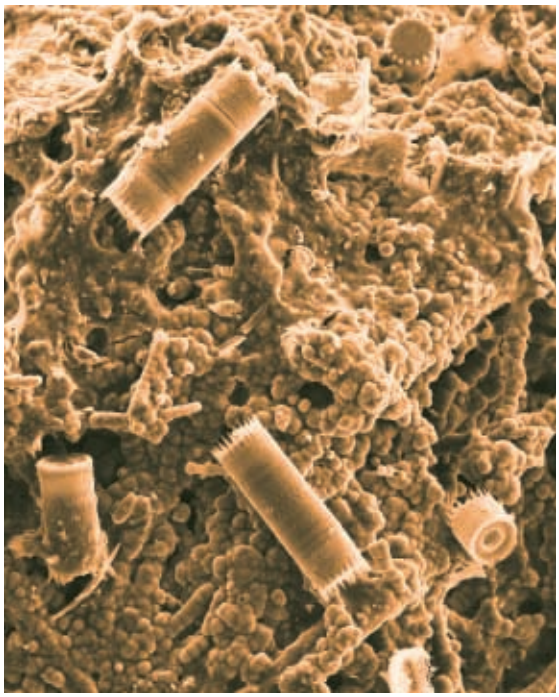
A computer-generated map *shows an intriguing array of steep-walled depressions on the floor of Yellowstone Lake. Also observed were pinnacles, spires, faults, and submerged former shorelines of the cold, high-mountain lake.*

Volcanic vent discovered at El Malpais

While exploring the Bandera lava flow in El Malpais National Monument (New Mexico) in 1999, the management assistant and the park archeologist discovered what is apparently a volcanic vent. Tentatively named "RK Crater," the vent is obscured from aerial view by a dense stand of mature ponderosa pine. It is about 60 feet in diameter and about 30 feet deep; an associated spatter cone is about 100 feet in height. The vent and cone are important pieces of the park's geologic puzzle. Once they had mapped the new discoveries, the two employees were able to interpret evidence of the vent on a topographic map, but still could not make out any evidence of its existence in aerial photos. The find underscores that new geologic discoveries are possible even in areas that have been previously studied.

colored, porous interior mantled with a coating of iron oxide, for laboratory analysis. Results indicate the spires are composed of amorphous silica; images from a scanning electron microscope reveal that samples contain remains from a broad variety of diatoms and botryoidal and filamentous bacteria. The spires also have trace amounts of heavy metals commonly associated with hydrothermal vents. Formation of both spires and circular depressions is related to deep fluid circulation that occurred over the past 12,000 years and left visible vents on the lake bottom. Other features seen during the survey are recent faults and submerged former shorelines. Though researchers hypothesized that the vent field in Bridge Bay is now inactive, the sheer number of features now known on the Yellowstone Lake bottom suggests very active vent sites, some of which may still be creating spires and other formations.

Later in 1999, one of the ranger-divers reported finding an outcrop of spirelike material in Lewis Lake, inside the southern boundary of the Yellowstone caldera. Researchers intend to return in 2000 to photograph features already discovered and to sample more spires, vent waters, and material from the lake bottom. They hope to map the entire floor of Yellowstone Lake—and possibly beyond—in future years. The study aims to understand the geologic processes that shape the lake and how they affect present-day aquatic populations.



A scanning electronic micrograph *of a small spire sample reveals siliceous remains of diatoms (cylindrical objects) and bacteria (objects shaped like bunches of grapes) as the primary constituents of the spire. Trace amounts of heavy metals commonly associated with hydrothermal vents are also present.*

Gathering Baseline Data

Sockeye salmon population status and local adaptation inventoried at Aniakchak

by Troy Hamon

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Small population sizes and often extreme weather conditions (even for Alaska) have led to poor documentation of the sockeye salmon populations in the Aniakchak River drainage, a designated wild river. However, a history of subsistence use, observations by recreational visitors and researchers, and aerial surveys by the State of Alaska establish the presence of sockeye salmon within the drainage. Considering the significance of fisheries to the area and the increasing pressures on federal managers to obtain adequate information to respond to subsistence issues, park resource management personnel began a project in 1999 with the purpose of identifying spawning locations and the overall number of spawning populations in the drainage. An ancillary goal was to obtain genetic samples and measurements of habitat and body dimensions for comparison with other populations of earlier origins.

Sockeye salmon populations in Aniakchak Caldera and the Aniakchak Wild River drainage were established recently relative to other sockeye salmon populations in southwestern Alaska. Most lake systems supporting sockeye in the region are of glacial origin and have been accessible to anadromous species (those that reproduce in freshwater but go to sea to feed and grow) for 20,000 years. Most of those lakes are also within 200 feet of sea level in elevation. By contrast, Aniakchak Caldera, in Aniakchak National Monument and Preserve, was formed by a massive volcanic eruption 3,400 years ago. It subsequently filled with water, housing a large lake similar to Crater Lake in Oregon. The hydraulic pressure on the caldera wall was eventually too great and a weak spot in the wall gave way between 1,800 and 3,400 years ago,

resulting in a tremendous flood. The flood established a connecting river between the lake, still present in one corner of the caldera though much smaller, and the Gulf of Alaska basin of the north Pacific Ocean, and allowed access by anadromous species. The lake, now known as Surprise Lake, is 32 river miles from the ocean, but lies at over 1,000 feet in elevation. Sockeye salmon accessed Surprise Lake at some time since the flood and established spawning populations there, persisting despite an eruption in 1931, which dumped six feet of volcanic material into the lake.

In this first year of inventory, the project successfully identified and sampled three spawning populations. Two of the spawning populations are in the caldera and one is downstream at Albert Johnson Creek, a major tributary to the river. Initial results from body size and shape measurements suggest limited mixing among the two populations sampled within the caldera. Genetic analysis is pending. In addition to sockeye salmon populations, the project obtained the first documentation of chinook salmon in the Aniakchak River drainage. Future study plans include completing characterization of the identified populations and their habitats, and additional efforts to identify more spawning populations at sites in the caldera and in Aniakchak River itself.

"This baseline information is especially critical because these populations are subject to commercial harvest outside and subsistence harvests inside the unit boundaries."

This project is supported and carried out by the National Park Service. It will provide a foundation of population information to ensure protection of sockeye salmon populations in Aniakchak National Monument and Preserve. This baseline information is especially critical because these populations are subject to commercial harvest outside and subsistence harvests inside the unit boundaries.

National Park Service resource managers *display anesthetized male and female sockeye salmon at the beach spawning area in Surprise Lake where the population status is being assessed. The wall of Aniakchak crater and the "Gates," where the lake flows out through the caldera wall to the Pacific Ocean, are visible in the background.*

New species discovered at Great Smokies

The first pilot year of the All Taxa Biodiversity Inventory (ATBI) in Great Smoky Mountains National Park was completed in 1999, with reports of 29 new species discoveries and 244 new park records. However, only a small portion of samples had been processed as the year came to a close. Ranges for some species have been quite extensive. For example, two species of slime molds were found in the park that were not previously known in the New World. Many more discoveries await as the second pilot year begins in 2000.

Partners in Science

Canon scholarship program expands in its third year

by Jean French

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The Canon National Parks Science Scholars Program awarded scholarships to eight doctoral students in 1999, twice the number of annual awards available in previous years. Each awardee receives $75,000, $25,000 per year for up to three years, to conduct dissertation research in the national park system.

The Canon National Parks Science Scholars Program is underwritten and supported by Canon U.S.A., Inc. Other collaborating organizations are the National Park Service, the National Park Foundation (NPF), and the American Association for the Advancement of Science (AAAS). The program was established in 1997 to encourage the best and brightest graduate students in all relevant scientific disciplines to conduct innovative park-related research and to encourage the use of national parks as laboratories for science.

Each year, the National Park Service develops specific research questions in four broad disciplines: the biological, physical, social, and cultural sciences. Graduate students from universities across the United States submit research proposals addressing one of the questions. During the first two years of the program, one student in each of the four categories was eligible to win a scholarship. In 1999 the program was significantly expanded, awarding scholarships to two students in each of the four categories. In addition, four honorable mention awards of $2,000 each are now available, one in each category.

This program is a unique public- and private-sector collaboration, the benefits of which became evident once again during the annual Canon National Parks Science Scholars Symposium in November 1999. In attendance were representatives of Canon U.S.A., Inc., the National Park Service, the NPF, and the AAAS, several of whom made presentations to the students. The Second Annual Canon Lecture on science and the national parks was given by NPS Historian Dr. Richard Sellars. All Canon Scholars (14, including the 1999 class) attended the two-day event in Washington, D.C. The students presented their research projects, taking advantage of the opportunity to discuss their research interests and further interact with NPS scientists, AAAS officials, NPF representatives, and their peers.

In the third year of this program, the Canon Scholars began to make significant, valuable contributions to science and the conservation of park resources through their research activities (see accompanying profiles). Since receiving their Canon scholarships, the 1997 class has authored a total of five peer-reviewed journal articles, published in *Science, Water Resources Research, Biological Invasions, Tree,* and *Ecology.* In addition the 1997 Canon Scholars' research has been described in *Discover,* the *Los Angeles Times, National Geographic, National Wildlife,* the *New York Times, Science News,* and other notable publications.

> "In the third year ... the Canon Scholars began to make significant, valuable contributions to science and the conservation of park resources."

The first Canon Scholar to complete the program, Tom Meixner, earned his Ph.D. in 1999. The rest of the 1997 Canon Scholars expect to earn their degrees in 2000, and the 1998 Canon Scholars are all on schedule to complete their degrees the following year. The 1999 Canon Scholars are just beginning their research. The 2000 competition is under way (visit www.nps.gov/socialscience for further information) and the 2000 Canon Scholars will be selected by 7 August 2000. Through the Canon National Parks Science Scholars Program these extraordinary scientists are able to learn, discover, invent, and create solutions to help preserve the nation's collective heritage in the 21st century.

Scientist Profiles

Tom Meixner, a 1997 Canon Scholar, is the first to complete the program. He earned his Ph.D. in 1999 from the University of Arizona. His dissertation is entitled "Alpine Biogeochemical Modeling: Case Studies, Improvements, and Parameter Estimation." In his research at Sequoia–Kings Canyon and Rocky Mountain National Parks, he developed modeling techniques to help in his study of alpine wilderness. In 1998 he authored a peer-reviewed journal article in *Water Resources Research.* Dr. Meixner is currently an assistant professor of hydrology at the University of California–Riverside.

Karen Short is studying the effects of frequent low-severity fires on bird populations in southwestern ponderosa pine forests. Karen is a 1998 Canon Scholar who is attending the University of Montana. She is collecting her data from Saguaro National Park, Walnut Canyon National Monument, and Grand Canyon National Park.

Andrew Suarez, a 1997 Canon Scholar at the University of California–San Diego, is measuring the impact of exotic species on natural systems. Andy has studied Argentine ant invasion, one of the most problematic biological invasions in southern California. Much of his research has been in Cabrillo National Monument. He has authored or coauthored four peer-reviewed journal articles since 1998 in *Science, Ecology, Tree,* and *Biological Invasions*. In addition, Andy's research has been described in many notable publications, including *Discover,* the *Los Angeles Times, National Geographic, National Wildlife,* the *New York Times,* and *Science News*.

Alice Wondrak is a 1999 Canon Scholar and a student at the University of Colorado–Boulder. She is exploring the environmental history of the "Yellowstone bear," from tourism icon to ecological indicator. Alice will conduct a broad examination of texts and artifacts, both contemporary and historical, including park literature, archival documents, and key informant interviews to identify the ways in which environmental history and cultural change have influenced park policies. Her research will identify opportunities for improved park interpretation.

CESUs Staffed in the West

As reported on page 27 of the 1998 *Natural Resource Year in Review,* four Cooperative Ecosystem Studies Units (CESUs) were selected in 1998: Rocky Mountains (hosted by the University of Montana), Colorado Plateau (hosted by Northern Arizona University), North Atlantic Coast (hosted by the University of Rhode Island), and Southern Appalachian Mountains (hosted by the University of Tennessee). In 1999 the National Park Service hired and placed research coordinators at the two CESUs in the West. Dr. Ron Hiebert, formerly the associate regional director for Natural Resources in the Midwest Region, reported to his duty station in Flagstaff, Arizona, in December; Dr. Kathy Tonnessen, previously an ecologist and the director of Biological Effects in the Air Resources Division, moved to Missoula, Montana, also at that time. The purpose of these positions is to foster communication among the many academic, governmental, and nongovernmental scientific institutions that have signed on as partners in the CESUs and to apply the wealth of research, technical assistance, and educational tools now available from the many partners to the management of parks.

Movies for managers: An advance in coral reef monitoring

by Caroline Rogers

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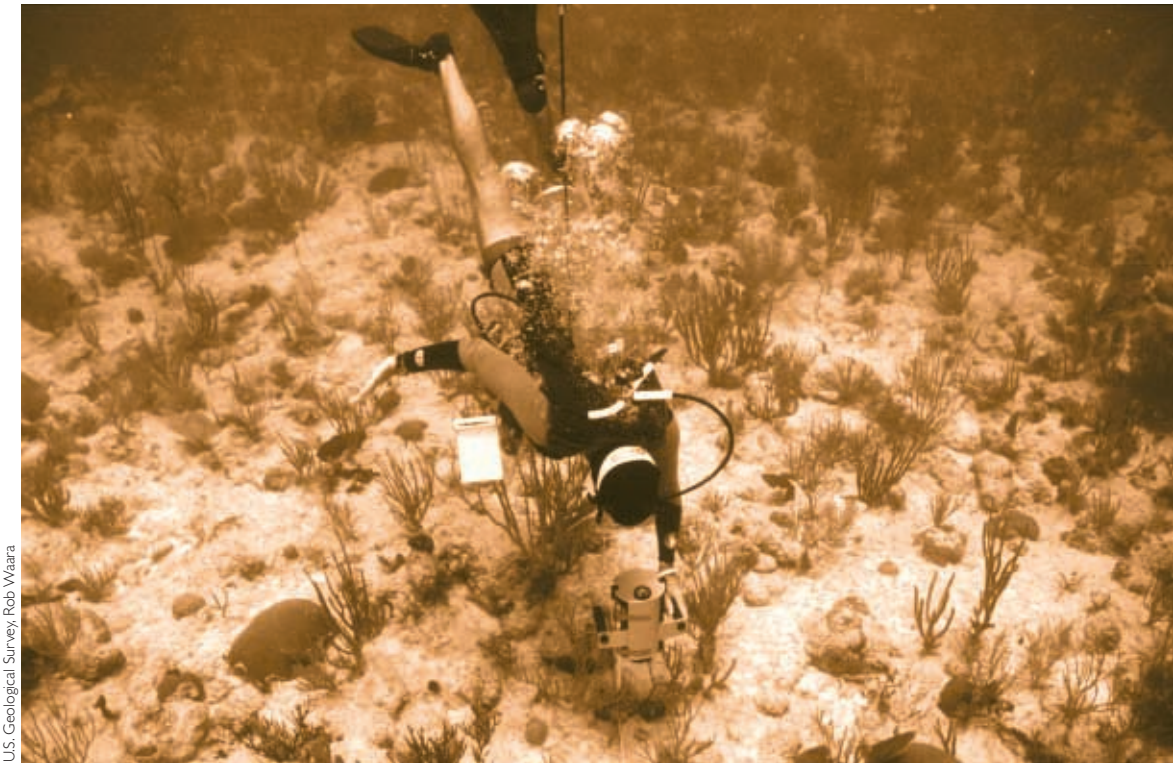
As part of the NPS-USGS Inventory and Monitoring Program, scientists with the U.S. Geological Survey (USGS) based in the U.S. Virgin Islands are working with other researchers and NPS resource managers to develop protocols to monitor coral reefs, reef fishes, sea turtles, seagrass beds, and water quality. During 1999 they developed a protocol for monitoring coral reefs using a digital video camera in an underwater housing and an innovative application of readily available computer software for processing the digital images. They have used this technique at several reefs in Virgin Islands National Park and at Buck Island Reef National Monument. Although "videography" has been employed by other scientists to monitor coral reefs, scientists at the Caribbean Field Station are the first to use it in conjunction with a sonar-based, underwater position-locating system that allows random selection of reef transects for videotaping. The selection of random, independent transects satisfies the criteria for rigorous statistical analysis and increases the likelihood that the data will be representative of the study site. The position-locating system also enables researchers to return to the same transects for future monitoring without the need for installation of permanent markers.

"The USGS biologist use videotapes to collect quantitative data on changes in abundance and condition of corals and other reef organisms."

The USGS biologists use videotapes to collect quantitative data on changes in abundance and condition of corals and other reef organisms along transects, as well as to document general, qualitative information about reefs. The tapes are immediately available for park managers and other scientists to view. Images from the tapes can also be sent electronically to other reef experts, for example, to confirm the presence of a particular coral disease. The tapes can be archived on CD-ROMs for future reference.



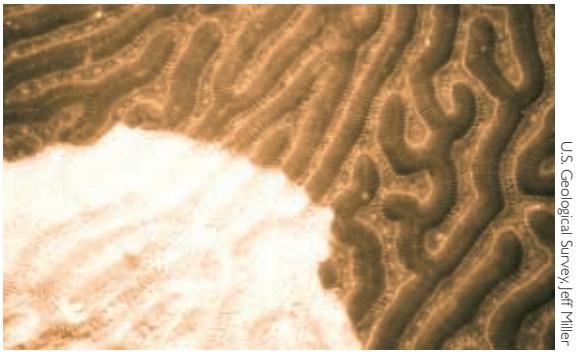
U.S. Geological Survey, Rob Waara

Using a digital video camera, *a USGS diver monitors the relative abundance of coral, sponges, algae, and other organisms, and records information on the presence of coral bleaching, diseases, and storm damage. In 1999 the USGS developed a video-monitoring protocol as a monitoring tool, which promotes standardized data collection. It is being used throughout the Caribbean and has utility in all coral reef parks.*

Videotapes are especially effective in recording the effects of a variety of stresses that cause conspicuous changes in the appearance of coral colonies—for example, breakage from hurricanes and boat anchors, and bright white patches from coral diseases and bleaching. They can also show recovery of reefs following damage.

Other, nonphotographic techniques for monitoring reefs require more time in the water and are therefore constrained by depth and time limits for scuba diving. They also depend on the diver's ability to identify a high diversity of organisms in the field. However, an experienced diver who lacks training in identification of reef species can collect data with the video method.

Jeff Miller, the biologist who has taken the lead on all aspects of this protocol, has trained NPS resource managers and people from Belize, Jamaica, and the Bahamas in the use of video cameras to collect quantitative data. More and more reef scientists are using this exciting new technology in Florida, the Caribbean, Australia, and elsewhere. It will be a very valuable tool as the National Park Service and other agencies begin to implement the National Action Plan to Conserve Coral Reefs, which was officially adopted on 2 March 2000. This plan calls for the design of a nationally coordinated, long-term program to assess and monitor U.S. coral reef ecosystems.



U.S. Geological Survey, Jeff Miller

Coral disease *(shown here in white) and coral bleaching, two threats to coral reefs, are being monitored with a digital video camera in Virgin Islands National Park. Quantitative and qualitative data can be derived from the videotapes and used by researchers and resource managers to address resource concerns in parks with coral reefs.*

Award-Winner Profile

Bill Halvorson receives top research honor

William Halvorson is the Cooperative Park Studies Unit leader at the University of Arizona–USGS Biological Resources Division. In 1999 he won the Director's Award for Natural Resource Research. Bill is a champion of research applicability in park management. His ongoing, professional support of park staffs and commitment to quality research and resource management in southern Arizona parks have enabled these units to overcome significant challenges. One of his trademarks is communication of research results through such means as a forum he helped found for the discussion and evaluation of natural and cultural resource programs. Additionally, he published *Bajada* (a research newsletter) for several years and co-edited the influential 1996 book, *Science in Ecosystem Management in the National Parks*.

Bill was particularly pleased to win the award at the same time that the Director's Award for Natural Resource Management was presented to Kathy Davis (see page 7). "Kathy … has contributed a lot to my understanding of what managers need in the way of information," he says. "I hope that I have … been helpful to her in gaining a better understanding of researchers' needs. Together we have been able to show the benefit of having two groups with fairly significant differences in needs, desires, and outlooks on life, working together to solve problems."

Bill sees the National Park Service "moving with giant strides, now that Richard Sellars' book has shaken the foundations, toward improving the scientific understanding of all resources in the parks." He says, "With added knowledge will come improved management. I look forward … to watching as … park managers gain in ability and comfort level at having so much more information at their fingertips." However, he cautions, "Having arrived at the point of moving strongly into the monitoring of resources in our parks, it will soon be necessary to beef up our capability to manage information…. Our systems for managing information are at a state that would relate … to a package delivery company that used propeller-driven airplanes, and the package pickup folks had to maintain and fly the planes as collateral duties."